ISSN NO. 2320-5407

Journal homepage: http://www.journalijar.com

INTERNATIONAL JOURNAL OF ADVANCED RESEARCH

RESEARCH ARTICLE

Distribution and population status of a critically endangered tree species *Symplocos racemosa* Roxb. in Eastern Ghats of Odisha

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Manuscript Info

Manuscript History:

Received: 12 September 2014
Final Accepted: 25 October 2014
Published Online: November 2014

Key words:

Endangered, Reproductive capacity, Symplocaeae, Eastern Ghats, Odisha

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Abstract

Symplocos racemosa (Roxb.) is a critically endangered medicinal tree found in the Eastern Ghats of Odisha. The present study was scientific data gathered on distribution, population biology along with reproductive capacity. Vegetation analysis was carried out by quadrat method and the density (D), frequency (PF), abundance (AB), basal area (BA), relative density (RD), relative basal area (RBA) and importance value index (IVI) and diversity index were evaluated. A total of 43 species were recorded, of which the maximum basal area was *Shorea robusta* (359.3153), followed by *Symplocos racemosa* (208.9172). Its flowering season is around November to January and the flowers come in medium, lush bunches. They are bright greenish-white in colour, turning brown before wilting. Inflorescence is terminal and axillary racemes. The highest percentage of floral buds of inflorescence was observed in P6-Thakurmunda (17.60) & P1-Patbil (16.80) population and the maximum reproductive capacity was observed in P2-Patbil population (72.31).

Introduction

Symplocos Jacq. is the only genus of Symplocaeae, comprising 300 – 400 species distributed mainly in the tropical and subtropical regions of Asia, Malasia, Ocenia and America (Cronquist, 1981). On the basis of floral morphology, the genus has been divided into four subgenera i.e., *Eusymplocos*, *Hopea*, *Microsymplocos* and *Epigenia* (Brand, 1901) or into two subgenera i.e., *Hopea* and *Symplocos* (Nooteboom, 1975). *Symplocos*, a woody angiosperm of the family Symplocaceae, is relatively a large genus consisting of approximately 290 species, of which 68 have been reported from India (Ahmad *et al*., 2005). *Symplocos racemosa* (Roxb.) is found wild in shade of the semi-evergreen forests. It is also a critically endangered tree, but is original distribution was in the Similipal Biosphere Reserve in Eastern Ghats of Odisha as well as the other parts of Odisha in Sambalpur, Takkapa, Keonjhar and Palaspal forest ranges. It is widely used by the traditional practitioners against various human diseases. It has a wide range of usage in Ayurveda and Unani medicines. The principle constituents are the three alkaloids loturine, loturidine and colloturine. Its bark is cooling, mildly astringent, light, and useful in treating dropsy, elephantiasis, filaria, liver complaints, bowel complaints, eye diseases, ulcers, menorrhagia, and leucorrhoea (Ahmad et al., 2005). Much attention have been paid to *S. racemosa* owing to its antifibrinolytic activity and inhibitory activity against snake-venom phosphodiesterase I (Ahmad et al., 2003) and some phenolic compounds as potential candidates for the therapy of arthritis (Choudhary et al., 2004). Due to such high medicinal importance, the species is being rapidly extracted from its native habitats. Moreover, the plants have great demand in both local as well as the international markets. Destruction of its natural habitat is one of the reasons for poor regeneration. Endemic plants attain rare, endangered or threatened status because of their restricted distribution, anthropogenic interferences, incidence of

pests and pathogens, or reproductive constraints (Krukebery and Rabinowitz 1985; Smith 1976). Recently scientists have shown an increasing interest on the reproductive biology of tropical trees such as *Leucaena* (Brewbaker, 1983), the genus *Acacia* (Tybirk, 1989; Tybirk, 1992; Buitlaar, 1993; Diallo, 1997) and the monospecific genus *Faidherbia albida* (Gassama-Dia, 2003). Therefore, the present study was conducted. The study has brought out information of the distribution, population status and reproductive capacity of *S. racemosa* in the Eastern Ghats, Odisha.

Materials and Methods

Intensive field investigations were undertaken by Taxonomy & Conservation Lab., Regional Plant Resource Centre, Bhubaeswar as part of the project on "Study on distribution, phytogeography and reproductive biology of *Symplocos racemosa* Roxb. in Odisha" funded by Forest & Environment Department, Govt. of Odisha. Population analysis was carried out the particular plants species were located site such as in every study sites, 20 x 20 m (400 sq m) size were taken from 10 sample plots each selected localities of Eastern Ghats of Odisha. Height and girth at breast height (GBH at 1.37 m above the ground level) of all trees oncoming in each quadrat was measured.

Primary analysis of the vegetation was carried out to obtain the values of various parameters like density, frequency, abundance, basal area and importance value index (IVI) (Gates, 1949; Curtis and Mc-Intosh, 1950; Misra and Puri, 1954; Curtis, 1951; Phillips, 1959; Misra, 1969; Mullar-Dombois and Ellenberg, 1974) by using the following formula:

$$\text{Density (D)} = \frac{\text{Total No. of Individuals}}{\text{Total No. of quadrats studied}}$$

$$\text{Relative Density (RD)} = \frac{\text{No. of Individuals of the species}}{\text{No. of Individuals of all species}} \times 100$$

$$\text{Percentage frequency (PF)} = \frac{\text{No. of quadrats in which species occurred}}{\text{Total no. of quadrats studied}} \times 100$$

$$\text{Relative Frequency (RF)} = \frac{\text{Number of occurrence of the species}}{\text{Number of occurrence of all species}} \times 100$$

$$\text{Abundance (AB)} = \frac{\text{Total no. of Individuals of the species}}{\text{Total no. of quadrats of occurrence}}$$

$$\text{Basal Areas} = gbh^2/4pi \; [pi = 3.14]$$

$$\text{Relative Basal Area (RBA)} = \frac{\text{Total basal area of the species}}{\text{Total basal area of all species}} \times 100$$

Importance Value Index (IVI) = relative density + relative frequency + relative basal area

A clear picture of the ecological status of a species with respect to the community structure can be obtained only by synthesising the percentage values of relative frequency, relative density and relative basal area or relative dominance. The values when added together give the IVI based on which an association is derived (Phillips, 1959).

Diversity Index:

For calculating Shannon Index of general diversity Margalef's (1968) formula was used as:

$$H = -\Sigma \frac{ni}{N} \log \frac{ni}{N}$$

Where H = Shannon index of general diversity

ni = No. of individuals of the species

N = No. of individuals of all species

Simpson (1949) index of Dominance:

The equation used to calculate Simpson index was

$$D = \Sigma (pi)^2$$

Where, D = Simpson index of dominance

pi = the proportion of important value of the *i* th species (*pi* = *ni* / N, *ni* is the important value index of *i* th species and N is the IVI of all the species).

As D increases, diversity decreases and Simpson's index was therefore usually expressed as 1 –D or 1/D.

Reproductive capacity:

For reproductive capacity, ten inflorescences on each tree were tagged, their lengths were measured and number of flowers on each inflorescence was counted. The number of fruit found on each inflorescence were collected and counted to estimate the reproductive capacity.

$$\text{Reproductive capacity} = \frac{\text{No. of fruits formed}}{\text{Total no. of flowers}} \text{ X } 100$$

Statistical analysis:

The results of present study were expressed as the mean values with standard error of more than three replicate in each population determinations. Data were statistically analyzed using Analysis of Variance (ANOVA) and Duncan Multiple Range Test (DMRT) using SPSS 11.5; SPSS Inc., Chicago IL, USA). Significance differences were determined at the $p \leq 0.05$ level.

Results and Discussion

Symplocos racemosa Roxb. is a native of North East India; Andaman & Nicobar; Nepal; Bangladesh; Myanmar; Thailand; China; Vietnam. It is growing on various agro-climatic regions in Odisha, namely Karanjia (Patbil), Jharbeda, Thakurmunda, Takkaba, Rebna RF and Sambalpur. The leafing began in June and end in March. From the second week of March to end of May the whole populations were partially defoliated on all studied sites. The flowering period, almost of the individuals took place between third weeks of November to second week of March with a flowering peak in December. Flowering is usually followed by fruiting, but some trees because of their situation and own specificities, failed to produce fruits. In the present study areas have given below the characteristics of the sampling sites of *Symplocos racemosa* (Table 1) and they are unevenly distributed on scrub jungles, and are often associated with *Shorea rubusta, Diospyros melanoxylon, Butea monosperma, Buchanania lanzan, Dioscorea species, Mangifera indica, Desmodium species, Eragrostis species, Hemidesmus indicus* and etc.

Table 1. Characteristics of the sample sites of *Symplocos racemosa* Roxb. population

Sampling sites	Elevation (m asl)	Latitude/ Longitude	Soil characters	Livestock grazing
Karanjia (Patbil) Mayurbhanj Dist	1078 ft	21°00 42.162' N, 86°0 04.630' E	Reddish with loamy	Tree cutting
Jharbeda Mayurbhanj Dist	1190 ft	21°41 27.66' N, 85°58 54.68' E	Red soil	-
Thakurmunda Mayurbhanj Dist	974 ft	21°00 28.951' N, 86°0 09.452' E	Brownish Sandy loamy	Tree cutting
Takkaba Forest, Angul Dist	1078 ft	21° 00 00.13' N, 84°00 38.934' E	Reddish with sandy loamy	-

The percentage frequency for selected locality was worked out separately and data are given in Table 2. The mean density studies included that not even a single plant species has a density value above one. Out of 43 species, about 8 species has a mean abundance value of one or above one. The mean basal area studies indicated that species having the maximum basal area was *Shorea robusta* (359.3153), followed by *Symplocos racemosa* (208.9172). All other species had a basal area value less than 60. The percentage of relative frequency was more or less same in *Shorea robusta* (9.78) & *Symplocos racemosa* (9.76) followed by *Diospyros melanoxylon* (8.94) and *Lagerstroemia parviflora* (6.50) respectively. *Symplocos racemosa* contributes higher relative density having the values of 35.87 while in *Shorea robusta* (25.23) and *Diospyros montana* (10.18) there are nearly equal values. The species maximum mean IVI indices were *Shorea robusta* (84.81), *Symplocos racemosa* (74.60) and *Diospyros montana* (23.89). Mean distribution studies indicated that only eight species had contiguous distribution and other species random distribution. The Shannon – Weiner diversity was 3.14 and Simpson diversity index 0.41. This

shows that the semi evergreen forests are less diversity due to dominance showed by *Shorea robusta, Symplocos racemosa, Diospyros montana* and *Diospyros melanoxylon.*

Table 2. Population biology of *Symplocos racemosa* Roxb. in different populations

S.No	Species name	D	AB	PF	BA	RD	RF	RBA	IVI
1	*Shorea robusta*	9.08	9.08	100.00	359.31	25.23	9.79	49.82	84.81
2	*Symplocos racemosa*	12.92	12.92	100.00	208.92	35.87	9.76	28.97	74.60
3	*Lagerstroemia parviflora*	1.66	2.50	66.67	36.30	4.62	6.50	5.03	16.17
4	*Diospyros melanoxylon*	2.41	2.64	91.67	38.93	6.71	8.94	5.40	21.05
5	*Diospyros montana*	3.66	6.29	58.33	57.80	10.18	5.69	8.01	23.89
6	*Terminalia chebula*	0.58	1.40	41.67	13.69	1.62	4.07	1.90	7.58
7	*Terminalia belerica*	0.17	1.00	16.67	1.99	0.46	1.63	0.28	2.36
8	*Syzygium cumini*	0.25	1.00	25.00	4.29	0.69	2.44	0.60	3.73

Total Basal Area = 721.258

Dominance Index = 0.5827

Diversity index; Simpson index = 0.4173; Shannon Index = 3.147

Aspect of flushing, flowering, role of pollinator and fruit setting data were recorded in nature carefully periodic visits to the target populations. It is generally natural propagation very low regeneration from root segments although it produces fruits with non viable seeds. It flowers almost the month of November to March in the year. Number of floral buds inflorescence, inflorescence length and reproductive capacity are given in Table 3 & 4 and also significance was accepted at $p \leq 0.05$ level. Among seven populations studied, highest mean number of floral buds per inflorescence was recorded in P6-Thakurmunda (17.60 ± 1.16) followed by P1 (16.80 ± 1.82) & P2-Patbils (16.20 ± 1.20) and lowest was observed in P7-Takkaba (10.00 ± 0.83) and P4-Jharbeda (12.40 ± 1.32) populations. Maximum length of inflorescence was observed in P2-Patbil (12.06 ± 1.07) followed by P3-Jharbeda (12.04 ± 0.59) populations and minimum in P7-Takkaba (02.66 ± 0.25) population. Reproductive capacity revealed that P2-Patbil population showed maximum capacity (72.31 ± 5.07) followed by P1-Patbil (56.81 ± 4.87) and a sharp decrease in activity was observed in P6-Thakurmunda (47.18 ± 5.75); P3-Jharbeda (44.62 ± 3.75); P7-Takkaba (40.01 ± 2.53) and P5- Thakurmunda (26.02 ± 4.53) respectively.

Table 3. Mean, SE and range of number of floral buds per inflorescence length in different populations*

Populations	No of floral buds per inflorescence			Inflorescence length (cm)		
	Mean ± SE	Min.	Max.	Mean ± SE	Min.	Max
P1- Patbil RF	16.80 ± 1.82^{a}	12.00	23.00	10.38 ± 0.91^{b}	07.90	13.20
P2- Patbil RF	16.20 ± 1.20^{ab}	14.00	20.00	12.06 ± 1.07^{b}	08.70	15.10
P3- Jharbeda RF	14.40 ± 0.81^{ab}	12.00	17.00	12.04 ± 0.59^{b}	10.80	14.20
P4- Jharbeda RF	12.40 ± 1.32^{bc}	09.00	16.00	11.62 ± 0.87^{b}	09.80	14.60
P5- Thakurmunda	14.40 ± 1.77^{ab}	11.00	21.00	11.58 ± 0.55^{b}	10.30	13.10
P6- Thakurmunda	17.60 ± 1.16^{a}	14.00	20.00	10.92 ± 0.37^{b}	10.20	12.10
P7- Takkaba RF	10.00 ± 0.83^{c}	07.00	12.00	02.66 ± 0.25^{a}	01.90	03.40

* mean values in the following row sharing a common letter are not statistically significant ($p \leq 0.05$ level) according to DMRT

Table 4. Mean, SE and range of reproductive capacity in different populations*

Populations	Reproductive capacity		
	Mean ± SE	Min.	Max
P1- Patbil RF	56.81 ± 4.87^{b}	34.78	80.00
P2- Patbil RF	72.31 ± 5.07^{a}	45.45	92.85
P3- Jharbeda RF	44.62 ± 3.75^{b}	21.42	60.00
P4- Jharbeda RF	49.82 ± 5.44^{b}	14.28	80.00
P5- Thakurmunda	26.02 ± 4.53^{c}	08.23	50.00
P6- Thakurmunda	47.18 ± 5.75^{b}	23.52	72.72
P7- Takkaba RF	40.01 ± 2.53^{bc}	10.00	75.00

* mean values in the following row sharing a common letter are not statistically significant ($p \leq 0.05$ level) according to DMRT

Conclusion

The natural regeneration of this species is very low due to the natural causes responsible for threat to plant species include changes in the abiotic parameters in the environment, such as long unfavourable weather spells and biotic parameters. The information from this present study on distribution, population status and reproductive capacity may help to discuss together with possible strategies for implementing *in situ* and *ex situ* conservation.

Acknowledgements

The author has express grateful thanks to Shri. Shashi Paul, I.F.S., Chief Executive, and Dr. P.C. Panda, Principal Scientist, Regional Plant Resource Centre, Bhubaneswar for the encouragement and facilities. Thanks are also due to Forest & Environment Department, Government of Odisha, Bhubaneswar for financial support to this project.

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